Does Offshoring Raise Female Employment in a Developing Country? Evidence from Indonesian Manufacturing Plants*

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Abstract

We investigate the effects of offshoring on female employment in a developing country as a recipient. We utilize unique data on outsourcing revenues from Indonesia's manufacturing plants. After correcting for offshoring's endogeneity through an instrument variable, we find substantial positive effects on the share of female workers, primarily driven by the increase in female workers without adversely affecting male employment. These positive effects are evident in production occupations but not in non-production ones. Furthermore, these effects are more pronounced in industries with a sizeable low-educated workforce, low-technology sectors, or light industries. Finally, we find that international outsourcing, rather than domestic outsourcing, is the key factor for female employment.

Keywords: offshoring, outsourcing, female workers, gender, employment, Indonesia

JEL codes: F16, J16, O15

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1. Introduction

Female labor-force participation holds significant implications not just for gender equality but also for the economic growth of developing countries. Shifting surplus labor from agriculture to manufacturing and service sectors fosters higher economic growth rates and lower poverty rates. Additionally, female labor-force participation influences individual and household decisions at the microeconomic level. For example, when women have better labor market opportunities, it encourages investment in girls' education (Duflo, 2012; Munshi and Rosenzweig, 2006). Moreover, income in the hands of women is linked to improved child health and nutrition and greater bargaining power within households (Thomas, 1990; Atkin, 2009).

This study delves into the connection between globalization and female labor participation. Using Indonesia's manufacturing plant-level data, we investigate the effects of offshoring on female employment in a developing country as a recipient. We refer to offshoring as international outsourcing, wherein a firm employs another company in a foreign country, whether the latter is an inside or outside organization, to carry out manufacturing tasks.

To measure the extent of offshoring activities at the host plants, we utilize unique data on revenues from manufacturing services to other firms or tasks outsourced by them, commonly known as contract manufacturing services (CMS).[1] We employ a Bartik shift-share instrument to extract the exogenous variation in offshoring activities. Our findings reveal substantial positive effects of offshoring on the proportion of female workers: a one standard deviation

[1] Fort (2017) uses CMS data for U.S. manufacturing plants to identify a plant's decision on production fragmentation.

increase in outsourcing revenues leads to a 14.3–18.2 percentage points rise in the share of female employees. This increase primarily stems from the growing number of female workers without adverse effects on male employment. In addition, the positive effects are evident in production occupations but not in non-production ones. Furthermore, the effects are more pronounced in industries with a sizeable low-educated workforce, low-technology sectors, or light industries. Notably, the study finds that international outsourcing, as opposed to domestic outsourcing, is the key factor affecting female employment.

This study's results hold implications for the discussion on the U-shaped relationship between economic development and female labor force participation (Mammen and Paxson, 2000; Verick, 2014). In low-income countries, female labor participation rates are high, with women primarily engaged in agriculture. As countries transition to middle-income status, these rates decline, as men tend to secure manufacturing jobs more readily than women. However, in developed countries, the rates rise again, driven by increased female employment in the service sector, particularly among those with higher education. Indonesia, classified as a lower-middle-income country with a workforce of 139.2 million in 2021 (International Labor Organization, 2022), predominantly comprises low-educated or low-skilled residents. Female residents have lower educational attainment than their male counterparts (see Table 1). The country's abundance of low-skilled and low-wage workers has led to its integration into international production networks, although the involvement of plants in international outsourcing remains relatively limited. The findings from our study suggest that increasing offshoring activities can contribute to boosting female labor force participation in middle-income countries like Indonesia.

Related Literature

Some authors have examined the gender component in response to globalization.[2] Black and Brainerd (2004) and Ederington et al. (2010) test Becker's (1957) famous hypothesis that employers who discriminate against a particular group (e.g., female or black workers) are disadvantaged and pushed out of business with increased competition. They explore how trade liberalization and foreign competition influence the gender wage gap and female employment.

Ozler (2000) analyzes plant-level data in Turkey and finds that an increase in the export share of output at the sectoral level leads to a higher proportion of female employees at the plant level. In contrast, Gaddis and Pieters (2017) investigate the effect of Brazil's trade liberalization on gender differences in local labor markets and find no evidence of increased female employment relative to male employment in response to trade liberalization. Focusing on Indonesian manufacturing, Oishi and Wei (2018) discover that tariff cuts are associated with reducing the share of female employment.

Foreign direct investment (FDI) has also been studied concerning gender outcomes.[3] Seguino (2000; 2005) argues that increased competition from low-wage producers led to outward FDI, especially from labor-intensive industries, from Taiwan to Southeast Asia and China during the 1980s, resulting in a wider gender wage gap in Taiwan due to women's concentration in such industries. Chen et al. (2013) find that exporting firms and foreign-invested enterprises employ

[2] Fontana (2003) provides a comprehensive review of early studies on the gender effects of trade liberalization.

[3] FDI is a kind of offshoring activity where tasks are performed inside foreign-affiliated firms. However, offshoring in this study covers international outsourcing, regardless of whether tasks are performed by affiliated or outside firms.

more female workers than domestic non-exporters, reducing the gender wage gap in the Chinese labor market. Fukase (2014) reveals that women with low education attainment receive wage premiums in foreign firms compared to the informal sector, potentially drawing women disproportionately toward job opportunities in foreign firms in Vietnam. Ouedraogo and Marlet (2018) use two composite gender indices for a panel of 95 developing countries and find that FDI inflows are positively associated with gender development (enhancing women's welfare) and negatively associated with gender inequality (reducing gender gaps). Helble and Takeda (2020) investigate the effects of FDI on the Cambodian labor market and find that FDI increases the likelihood of women working in the formal sector but that it little reduces the gender wage gap.

Previous studies have often overlooked gender outcomes in the context of offshoring. Furthermore, when examining the effects of offshoring on labor markets, the focus has primarily been on the perspective of the source country rather than the host country. For instance, studies by Ebenstein et al. (2014) and Kovak et al. (2021) explore the wage effects of offshoring in the United States, whereas Hummels et al. (2014) investigate these effects in Denmark. However, a few exceptions stand out. Coniglio and Hoxhaj (2022) find that foreign and domestic firms participating in global value chains increase female employment, particularly for low-skilled female workers, but participation in global markets has limited effects on reducing the gender wage gap in Vietnam. However, they do not address the potential endogeneity of a firm's decision to join global value chains. Peri and Poole (2012) come closest to the current study. They use a firm's export intensity as a proxy for offshoring in Brazil, the host country, and employ a shift-share instrumental variable for exports. Their findings suggest no statistical relationship between exports and the share of female workers in firms.

In view of the previous research, our main contribution to the literature can be summarized in three key aspects. First, by utilizing CMS data, we can examine the general effects of – domestic or international – outsourcing on gender outcomes. While some studies have examined the effect of outsourcing on the wages of outsourced or remaining workers (Goldschmidt and Schmieder, 2017; Drenik et al., 2020; Deibler, 2022), none have specifically investigated its impact on gender outcomes. The second contribution lies in using CMS data in the context of offshoring.[4] Previous studies[5] have often relied on indirect proxies for offshoring due to data limitations, such as measuring offshoring using the share of imported materials in total non-energy input purchases (Feenstra and Hanson, 1996a, b).[6] Third, we assess the gender impacts of various offshoring activities based on host plants' trade status. We expand upon Peri and Poole (2012), who examined the impact of exporting, by also considering the impact of material imports. Considering plants' import status is crucial, as offshoring in developing countries typically involves material imports from developed countries. Relatedly, recent studies have highlighted that non-exporting firms are involved in the global market through domestic production networks (Dhyne et al., 2021; Chen et al., 2022). Our offshoring measure enables us to explore the gender impact of such indirect exporting.

The remainder of this paper is organized as follows: Section 2 provides the conceptual

[4] Refer to Hummels et al. (2018)'s survey paper on the offshoring literature.

[5] Many authors use Feenstra and Hanson's (1996a, b) approach to measure offshoring. For instance, see Crinò (2010a), Hummels et al. (2014), and Baum et al. (2022). Some authors further extend their approach to measure service offshoring (e.g., Amiti et al., 2005; Crinò, 2010b).

[6] In calculations, they make the "proportionality assumption" that each industry imports an input of material or service in the same proportion as the economy-wide input imports. This type of offshoring proxy has received criticism for its negligence of the heterogeneity in import shares across industries (Yoo, 2019).

frameworks, Section 3 describes the data and variables used, Section 4 explains the empirical strategy, and Section 5 presents the estimation results. Finally, the study's concluding remarks are discussed in Section 6.

2. Conceptual Frameworks

There are three theoretical ideas regarding the relationship between offshoring and gender outcomes in employment. First, routine tasks can be easily automated and offshored to low-wage, unskilled laborers in developing countries (Autor et al., 2003; Ebenstein et al., 2014).[7] It is often argued that women have a higher tolerance for repetitive tasks, greater agility, and lower skills and wages (Standing, 1999; Fontana, 2003; Atkin, 2009). Consequently, as developed countries offshore routine tasks, the demand for female workers relative to male workers is expected to increase in the host countries.

The next idea is related to the brain vs. brawn hypothesis, which posits that women have lower physical skills than men (Juhn et al., 2014). Offshoring may entail the adoption of new technology in host firms, such as automated or computerized production processes, at the request of firms in the source countries providing offshoring tasks. This new technology reduces the need for physical skills, an area where men typically have an advantage, increasing female employment. In other words, the new technology brought in by offshoring complements female labor. Juhn et al. (2014) tested this hypothesis in the context of trade liberalization using

[7] Refer to Autor et al. (2003) for a formal definition of routine tasks. Some examples include assembling parts in TVs and printers, attaching pieces to metal or wooden articles, and sewing buttons and decorative trimmings to clothing.

Mexican establishment-level data. They found that increased export opportunities due to the North American Free Trade Agreement led to the adoption of new technology (e.g., computerized production systems), which complemented female labor by reducing the need for physical skills.

An opposing but related theory is also possible. Offshoring in host firms involves importing intermediate inputs embodying high-level technology or transferring such technology, which requires skilled workers. In this case, offshoring triggers skill-biased technological changes in the host firms (Acemoglu et al., 2015). They argue that for a low level of offshoring, an increase induces a skill-biased technological change in both developed and developing countries, leading to an increase in the relative demand for skilled workers and the skill premium in both groups. Since men tend to be more educated than women in developing countries, offshoring is likely to increase male employment while decreasing female employment.

In summary, the above theories suggest that the effects of offshoring on female employment in host firms are ambiguous, warranting empirical investigations.

3. Data

The primary data source is the *Annual Survey of Medium and Large Manufacturing Establishment* from 2001–2012, published by Statistics Indonesia (Badan Pusat Statistik or BPS). The dataset includes information on plants with 20 or more employees and provides data on production and cost at the plant level. This includes details like the total production value, revenue from manufacturing services, number of workers in production and non-production occupations by gender, and book values of fixed capital assets, materials, electricity, and energy

inputs. The dataset also reports on the plant's location, industry classification for its main product, export and import status, and share of foreign capital. We use each province as a geographical unit, and industries are defined based on the three-digit International Standard Industrial Classification (ISIC) Revision 3. Firms with a foreign capital share greater than 20% are considered multinational enterprises (MNEs) or FDI firms.[8]

To calculate a plant's value added, we subtract intermediate consumption, such as materials, electricity, and energy inputs, from its total revenue. The obtained value added and revenue from manufacturing services are deflated using the wholesale price index (2000 = 100). Non-production workers are those engaged in non-manual tasks such as factory supervision, administration, logistics, and research and development (R&D). The initial capital stock is proxied by fixed tangible assets deflated by the price index for gross fixed capital formation in Indonesia's System of National Accounts. Subsequent capital stock in the following periods is constructed using the perpetual inventory method, assuming a depreciation rate of 9% (Brandt et al., 2012). Skill intensity is defined as the share of workers in non-production occupations in the total employment of a plant. Total factor productivity (TFP) is obtained by estimating the Cobb–Douglas value-added production function for each two-digit ISIC industry.[9]

The revenue from manufacturing services is a key variable for our study and represents the income from tasks outsourced by other firms.[10] We find that the revenues from manufacturing

[8] According to Blalock and Gertler (2009), the samples of foreign-affiliated firms obtained under this definition are mostly equivalent to those doing business under Indonesia's foreign capital investment licenses.

[9] Following Ackerberg et al. (2015), we estimate the production function using material as a proxy for unobserved productivity. We use the Stata code used by De Loecker and Warzynski (2012) to estimate the production function.

[10] According to the survey, "Manufacturing services are industrial activities that serve others. In these

services play a significant role in the total revenues of Indonesian plants. Among the plants with positive outsourcing revenues in the sample, the mean (median) ratio of outsourcing revenues to total revenues is 0.49 (0.42). However, the revenues from manufacturing services encompass activities outsourced by domestic and foreign firms. To differentiate international outsourcing or offshoring activities, we use an interaction term between the plant's revenue from manufacturing services and a dummy variable indicating the plant's involvement in international trade. When plants perform tasks outsourced by partner firms in foreign countries, they may also import inputs and export intermediate or final products to them. To account for this, we consider three dummy variables. The first dummy variable is set to one if the plant imports materials and exports products, the second if the plant exports products, and the third if the plant imports materials. The interaction term with the first dummy variable represents narrowly-defined offshored activities, while the interaction term with the second or third represents broadly-defined offshored activities.

It is worthwhile to remark more on these interaction terms. Among the total observations in the sample, plants engaged in outsourcing activities account for 18%, with narrowly-defined offshoring plants making up 6% of them and broadly-defined offshoring plants holding 19% (exporting plants) and 14% (importing plants). This indicates that plants engaging in international outsourcing are relatively minor in Indonesia. Unlike the offshoring measures used in previous studies,[11] our definition of offshoring includes both outsourcing to affiliated

activities, the materials are supplied by others while the processor processes and receives payments for these activities as compensation."

[11] For instance, Ebenstein et al. (2014) and Kovak et al. (2021) use employment of foreign affiliates of U.S. MNEs as a measure of offshoring.

and outside firms. Among the narrowly-defined offshoring plants in the sample, 46% are MNEs, suggesting that many offshored tasks are performed within foreign affiliates. Among the broadly-defined offshoring plants, 27% and 30% are MNEs with exporting and importing activities, respectively.

However, there are some limitations regarding the data and our measures of offshoring. The interaction terms cannot rule out cases where the plant imports materials that are not directly related to the offshored activities or exports goods that are unrelated to these activities. To validate the suitability of our offshoring measures as proxies for international outsourcing, we compare them with the foreign value-added share of gross exports, a measure often used in the literature (Feenstra, 2017). We obtain the foreign value-added share of gross exports by industry in Indonesia[12] from the OECD Trade in Value-Added (TiVA) database and compare it with our narrowly-defined offshoring measure.[13] Figure 1 displays the results, ranking industries based on our offshoring measure. We find that highly ranked offshoring industries tend to have a greater share of foreign value added in gross exports (Spearman's rank correlation coefficient is 0.79). This suggests that our offshoring measure is consistent with the one used in the literature and can represent reasonably well international outsourcing.

To investigate whether the effect of offshoring on female employment varies across industries, we classify them based on a few dimensions. First, using detailed data from the 2006 survey

[12] This is the value of imported intermediates embodied in the Indonesian industry's exports as a share of its total gross exports.

[13] Since foreign value-added share by industry in the TiVA database is only available at the two-digit industry level (ISIC), we aggregate our offshoring measure (originally at the three-digit level) to make it comparable.

on workers' educational attainment, we compute the share of educated workers (high-school graduates or above) in the total employment for each plant.[14] We obtain the average share of educated worker over plants for each industry. Industries are then classified into those employing educated workers intensively and those that do not, using the median value as the threshold. Second, industries are categorized as high or low technology according to the OECD classification (2003).[15] Third, following Oishi and Wie (2018), industries are classified as light or heavy.[16]

Table 2 provides summary statistics, indicating that, on average, female workers constitute 41% of total employment or production occupations in Indonesian plants. However, the share of female workers in non-production occupations is 6 percentage points smaller than in total employment or production occupations.

[14] Since the share of workers in the Indonesian manufacturing workforce with a college degree is very small (only 4%), we define educated workers as high school graduates or above (see Table 1).

[15] Because this classification is based on R&D intensities of industries in OECD countries, it does not necessarily reflect the technology level of Indonesian manufacturing.

[16] Light industries include food and beverages, textiles, wooden commodities, paper and printing, furniture, and recycling. Heavy industries include chemicals, petroleum and rubber, metal products, machinery, and transportation.

4. Empirical Strategy

We consider the following econometric model:

$$femalesh_{ijt} = \alpha + \beta_1 lnouts_{it} + \beta_2 trade_{it} + \beta_3 lnouts_{it} \times trade_{it} + \boldsymbol{X'_{it-1}}\boldsymbol{\beta} + \theta_{jt} + \theta_{rt} + \varepsilon_{ijt} \quad (1)$$

where *i* represents an index for a plant, *j* for an industry, *r* for a region where the plant is located, and *t* for time or year.[17]

The dependent variable is the share of female employment of plant *i* at time *t*.[18] $lnouts_{it}$ is the logarithm of one plus outsourcing revenues of plant *i* at time *t*. $trade_{it}$ is a dummy variable for plants engaged in international trade, categorized into three types: plants that export products (exp_{it}), those that import materials (imp_{it}), and those that import materials and export products simultaneously ($exim_{it}$). The interaction term $lnouts_{it} \times trade_{it}$ represents the interaction term between outsourcing revenue and one of the three dummy variables. $\boldsymbol{X'_{it-1}}$ is a row vector of control variables for plant characteristics, such as value added, the capital-to-value-added ratio, skill intensity, TFP, and a dummy variable for MNEs or FDI. All plant control variables, except for FDI, are one-year lagged to address simultaneity concerns. Additionally, the trade status of a plant are potentially endogenous because plant-specific productivity shocks may require it to hire more female workers, and meanwhile influencing the plant's trade status. Thus, we include lagged TFP to account for plant-specific

[17] When a plant produces multiple products, the industry classification is based on its main product.

[18] Alternatively, we also consider the absolute number of female or male workers as the dependent variable.

productivity shocks.[19] θ_{jt} represents the fixed effect for an industry (three-digit ISIC)-time pair, and θ_{rt} is the fixed effect for a region-time pair.[20]

The focus of interest lies in the interaction term. If offshoring increases the demand for female labor, we expect positive coefficients for β_3 in both narrow and broad cases. Given that we employ industry-time and region-time fixed effects in Equation (1), the identification of parameter β_3 primarily relies on variations across plants for a given industry-time pair and a given region-time pair.[21]

One potential concern is endogeneity in offshoring activities. Plants with more female workers might have more offshored tasks, reverse causality. Additionally, omitted variable problems may arise. First, unobserved industry-wide technology shocks could affect both offshoring and female labor demand. We include the fixed effects for an industry-time pair θ_{jt} to account for time-varying industry-specific technology changes. Next, the wage difference between men and women could be an important factor in the demand for female labor. Since the data lacks information on workers' wages by gender at the plant level, we include the fixed effects for a region-time pair θ_{rt} as well as θ_{jt} to control for wage gaps at regional and industry levels,

[19] Previous studies (e.g., Lileeva and Trefler, 2010) employ a weighted average of tariff rates as an instrument for exports or imports. Unfortunately, this instrument does not work for our needs. As an instrument for the import dummy, we have considered the weighted average of import tariff rates using the coefficients in the input-output table as a weight. Because this instrument varies across industries and time but not across plants, and we use industry-time fixed effects, we cannot employ it.

[20] Note that the individual fixed effects, such as the industry fixed effects, the region fixed effects, and the time fixed effects, are subsumed into θ_{jt} or θ_{rt}.

[21] When we use the plant fixed effects with or without the industry-time and region-time fixed effects, the results are largely insignificant. This is because the revenue from outsourcing is zero for most plants, and it does not vary much for plants with a positive outsourcing revenue during the sample period.

respectively.

Despite these fixed effects, we might still face omitted variable problems at the plant level. Unobserved technology changes could be correlated with a plant's decision to upgrade technology to attract offshoring and change the demand for female labor. To address this issue, we adopt a Bartik shift-share instrumental variable strategy, modifying Hummel et al.'s (2014) instrument. The instrument of outsourcing revenues is the weighted average of the share of world import demand, with the weight being plant *i*'s initial production share of product *k*:

$$\boldsymbol{IV_{it}} \equiv \sum_{\boldsymbol{k}} \boldsymbol{\omega_{ikt_0}} \frac{\boldsymbol{WID_{kt}}}{\boldsymbol{WID_t}} \tag{2}$$

where WID_{kt} represents the value of world imports of product *k* at time *t*, excluding imports from Indonesia; WID_t is the total value of world imports at time *t*, net of Indonesian imports; and ω_{ikt_0} is the share of product *k* in the total production of plant *i* in the initial year t_0.[22] We use this instrument in the two-stage least squares (TSLS) estimations.

A valid instrument should correlate with the offshoring activities of plants while remaining unrelated to their technology shocks or female employment. In our case, this instrument positively correlates with plant *i*'s outsourcing revenue. In other words, when an Indonesian plant experiences an increase in the share of world import demand for the specific products it produces, its offshoring activities tend to rise accordingly. However, fluctuations in the share of world import demand over the sample period are essentially driven by demand shocks that

[22] Data on world imports at the Harmonized System (HS) 6-digit level are obtained from the United Nations Comtrade Database. We use the concordance table between HS codes and Indonesian product codes provided by BPS to construct the instrument variable.

are external to Indonesian manufacturing plants and are less likely to be correlated with technology shocks. Therefore, our instrument effectively isolates the portion of offshoring variation that is exogenous to host-plant shocks, enabling us to identify the causal effects of offshoring on female employment. The novelty of our instrument variable is that it varies with respect to plant *and* time. Since female employment and offshoring might be determined simultaneously, we use a plant's share of product k in the initial year to reduce simultaneity bias. Note that we instrument the interaction term between plant i's outsourcing revenue and its trade status with the interaction of the instrument variable and plant i's trade status.

5. Results

5.1. Effects on Female Employment

Table 3 displays the ordinary least squares (OLS) results, with standard errors corrected for clustering at the plant level. The first column estimates Equation (1) without an interaction term,[23] while the subsequent columns introduce an interaction term. It shows that outsourcing, irrespective of a plant's trade status, decreases the share of female employment. However, when a plant engages in international trade (exporting, importing, or both), the share of female employment increases with outsourcing revenues (Columns (2)–(4)). Regarding control variables, an increase in the ratio of capital to value added, skill intensity, or TFP leads to a decrease in female labor share. MNEs' affiliates have a higher share of female workers. Lastly, among plants without outsourcing revenues, those involved in trade have a higher share of

[23] We thank the referee for suggesting this specification.

female workers.[24]

Table 4 presents the results based on the instrumental variable estimation. We observe that the coefficients of offshoring in TSLS are notably larger than in OLS. This suggests that the effects of offshoring are underestimated in OLS due to omitted variable bias. Offshoring often triggers technological changes in plants, and these shocks can affect female labor in various ways. The smaller coefficients in OLS may imply that technology shocks from offshoring tend to favor skilled or male workers while diminishing the demand for female workers. However, when we employ an instrument to control for the unobserved link between offshoring and technology change, the effects of offshoring on female employment are substantially larger. This outcome is not due to a weak instrument problem, as the *F* statistics at the first stage are above or close to 10.[25]

Table 4's results remain qualitatively similar to Table 3, except for the first column. In IV estimation, an increase in outsourcing revenues raises female employment (Column (1)). However, the positive effect is evident only for plants with outsourcing revenues engaged in international trade (Columns (2)–(4)).[26] Notably, plants conducting outsourced tasks with imported materials (i.e., the interaction with the import dummy) increase their female share regardless of their export status (Column (3)). These plants may indirectly export products by

[24] Oishi and Wie (2018) find similar results: the share of female labor is higher for exporting plants than for non-exporting ones.

[25] Staiger and Stock (1997) suggest that the first-stage *F* statistic should be above 10 to avoid a weak instrument problem. See also Table A1 in Appendix for the first-stage estimates.

[26] We also tried a specification that included two interaction terms jointly: one with the export dummy and the other with the import dummy. However, since the first-stage *F* statistics were very low, we present results using each interaction term separately.

selling intermediate or final goods to other domestic or foreign firms in Indonesia that re-export goods.

The results imply that international outsourcing, rather than domestic outsourcing, is the key factor affecting female employment. However, not all outsourcing plants involved in international trade experience increased female share. Figure 2 illustrates how the marginal effects of trade on the female share vary with outsourcing revenues for narrowly-defined offshoring plants.[27] The net impact is significantly positive for plants with high outsourcing levels but becomes negative and insignificant for those with low outsourcing levels.

Using the coefficients from offshoring variables (Columns (2)–(4) in Table 4), we calculate the marginal effects of outsourcing revenues. A 10% increase in outsourcing revenues raises the female employment share by 0.6–0.7 percentage points, and these effects are statistically significant at the 5% level or higher. Considering the standard deviation of outsourcing revenues for plants with positive outsourcing revenues, these effects have substantial economic significance: a one standard deviation (2.6) increase in outsourcing revenues leads to a 14.3–18.2 percentage point increase in the share of female workers.

Our findings align with Coniglio and Hoxhaj (2022), who observe an increase in female employment for foreign and domestic firms participating in global value chains in Vietnam. However, our results differ from those of Peri and Poole (2012), who find no relationship between a firm's intensity of exports (a proxy for offshoring) and the share of female workers in Brazilian firms. However, one should note the difference between our study's identification strategy and theirs. While we rely on variations across plants for identification, they use

[27] We are grateful to the referee for suggesting this graphical presentation.

variations over time within a firm, which is a more demanding estimation approach.

The last two columns of Table 4 present robustness checks. To explore the role of foreign ownership or FDI in female employment, we consider foreign subsidiaries that undertake tasks offshored by their parent firms. The results in Column (5) of Table 4 indicate that outsourcing positively affects female employment for foreign-owned plants.[28] In the last column, we use export values[29] instead of the exporter dummy to examine whether trade, not international outsourcing, drives the results.[30] The coefficient on export values is insignificant, suggesting that outsourcing combined with exports, rather than exports alone, drives the results.[31] However, caution is needed with this finding, as only about half of the plants provide the share of exports in the survey, leading to a substantially reduced number of observations.

The results thus far demonstrate that offshoring induces Indonesian firms to increase the share of female workers in their production. However, they do not indicate whether these firms simply replace male workers with female workers or increase the absolute number of female workers. Clarifying this aspect is crucial for understanding the welfare implications for workers. In Table 5, we consider the logarithm of the number of male and female workers, respectively, as the dependent variables (Columns (1)–(8)). We omit to report the estimates on control variables of plants to save space. For broadly-defined offshoring activities, we observe an increase in female employment (Columns (4) and (6)), but the effects on male employment are

[28] We also consider the triple interaction term between outsourcing revenues, FDI dummy, and trade status. We find that it is insignificant, and the first-stage *F* statistics are very low.

[29] In the survey, plants report the share of exports in total sales, from which we calculate export value.

[30] We thank the referee for suggesting this exercise.

[31] In estimation, we use the same instrument for export values as the one used for outsourcing revenues.

mixed. Offshoring decreases male employment for plants exporting products (Column (3)), while it does not affect male workers for plants importing materials (Column (5)). In the case of narrowly-defined offshoring, it raises female employment without any effects on male employment (Columns (7)–(8)). We also use the logarithm of women's relative employment to men as the dependent variable. The last column shows that narrowly-defined offshoring raises the ratio of female to male workers of a plant. Overall, these findings suggest that offshoring increases female employment without necessarily reducing male employment.

In Table 6, we test the prediction that the previous positive effects of offshoring on female employment are more pronounced in production tasks than non-production ones, as jobs that developed countries offshore are primarily related to production tasks (Ebenstein et al., 2014). The first-order effects of outsourcing are positive both for production and non-production occupations (Columns (1)–(2)). However, the coefficients of the interactions are significantly positive only for production occupations (Columns (3), (5), and (7)), suggesting that the affirmative effects of offshoring on female employment are concentrated in production occupations.[32] The last column considers the skill intensity of female workers as the dependent variable, which is measured by the ratio of female non-production workers to female workers. The result shows that narrowly-defined offshoring decreases the female skill intensity, which is consistent with the result in Column (7).

[32] The results for non-production workers should be interpreted with caution because the corresponding first-stage *F* statistics are far below 10.

5.2. Heterogeneous Effects on Industries

The effects of offshoring on female labor can vary depending on industries, as offshoring activities tend to be concentrated in specific industries, as shown in Figure 1. First, the effects are expected to be more prominent in industries with a sizeable low-educated workforce, as offshored tasks are often routine and require unskilled labor. Second, the effects are likely more substantial in industries with low technology, where production tasks are relatively simple and routine, making them easier to offshore. Similarly, the effects are expected to be more pronounced in light industries (e.g., food and beverages and textiles) than in heavy industries. These discussions align with traditional trade theory. Developing countries like Indonesia are abundant in unskilled labor and specialize in industries with a large low-educated workforce, low-technology sectors, or light industries. The Heckscher–Ohlin theory implies that offshoring activities similar to international trade are likely to concentrate on such industries.

The following analysis tests the heterogeneous effects across industries, focusing specifically on production occupations.[33] First, we classify industries into two subsamples based on the educational attainment of plant employees: industries that heavily employ low-educated workers and those that intensively employ educated workers. We only report the results for the former, as the number of observations are not enough to evaluate the effects of offshoring for the latter. Columns (1)–(4) in Table 7 present the results. Regardless of which offshoring measures are used, the coefficients of the interaction terms for industries with a large low-educated workforce are all significantly positive. Furthermore, their magnitudes are larger

[33] As expected, we find that the heterogeneous effects of offshoring are all insignificant for non-production occupations. These results are available upon request.

(Columns (2)–(4) of Table 7) than those in the full sample (Columns (3), (5), and (7) of Table 6). These findings suggest that the effects of offshoring on female production workers are more pronounced in industries with a high concentration of low-educated labor.

Second, we utilize the OECD classification of industry technology levels. Columns (5)–(8) in Table 7 reveal that the coefficients of the interaction terms for low-technology industries are all significantly positive. Likewise, the results for light industries are similar (Columns (9)–(12)). Again, we observe that the estimates of all interaction terms in low-technology and light industries are larger than those in the full sample. Therefore, the effects of offshoring on female production workers are more pronounced in industries with low technology or light industries.

Whether these results are genuinely influenced by offshoring or merely driven by the fact that most Indonesian plants belong to these industries[34] and have offshoring activities while employing many female workers raises concerns about endogeneity, which we address using an instrumental variable strategy. This issue can be understood by comparing the OLS and TSLS results. Although not reported, we find that the OLS estimates of the coefficients of the interaction terms show little difference between the full sample and the three industry subsamples. In contrast, as discussed above, the IV estimates differ significantly between them. In other words, by employing an instrument to correct for endogeneity, we can identify industry heterogeneities in the effects of offshoring.

[34] In the sample, 86% of plants belong to industries employing low-educated workers intensively, 92% belong to low-technology industries, and 73% belong to light industries.

6. Concluding Remarks

We empirically investigate the impact of international outsourcing or offshoring on female employment in a developing country as a recipient. Our study uses unique plant-level panel data from Indonesia, which includes information on plant outsourcing revenues. To address the endogeneity of offshoring, we employ an instrument variable, enabling us to isolate the exogenous variation in offshoring and identify causal effects. The findings indicate that offshoring considerably increases the share of female employment by increasing the number of female workers without necessarily reducing male employment. These effects are particularly prominent in production occupations but not in non-production jobs. Furthermore, we observe that the positive effects of offshoring are more pronounced in industries with a large low-educated workforce, low-technology industries, or light industries. Lastly, domestic outsourcing, as opposed to international outsourcing, does not have any discernible impact on female employment.

In developing countries like Indonesia, female labor force participation is crucial for economic growth. The U-shaped hypothesis suggests that female labor participation rates are lowest in middle-income countries like Indonesia. Our results support that increasing offshoring activities can enhance women's labor force participation in such countries.

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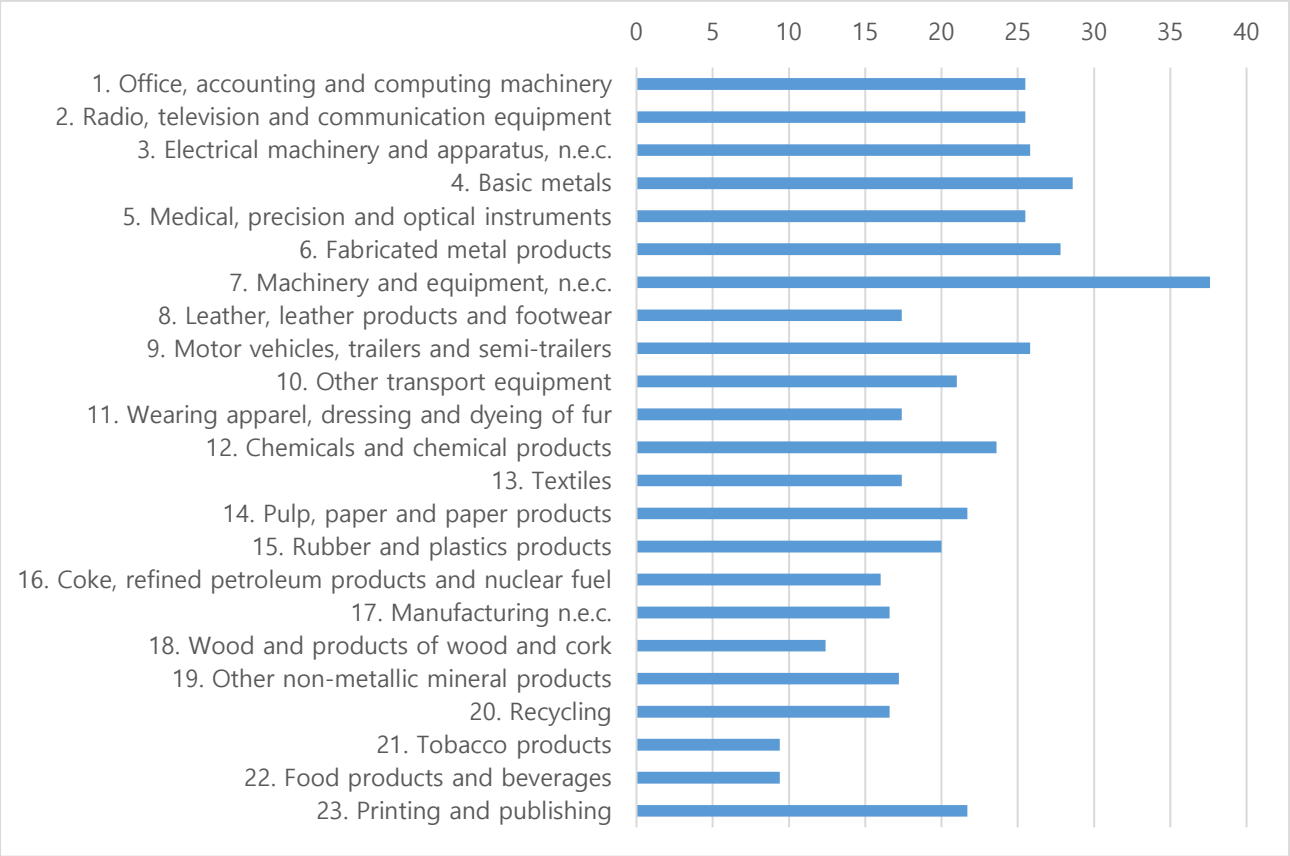
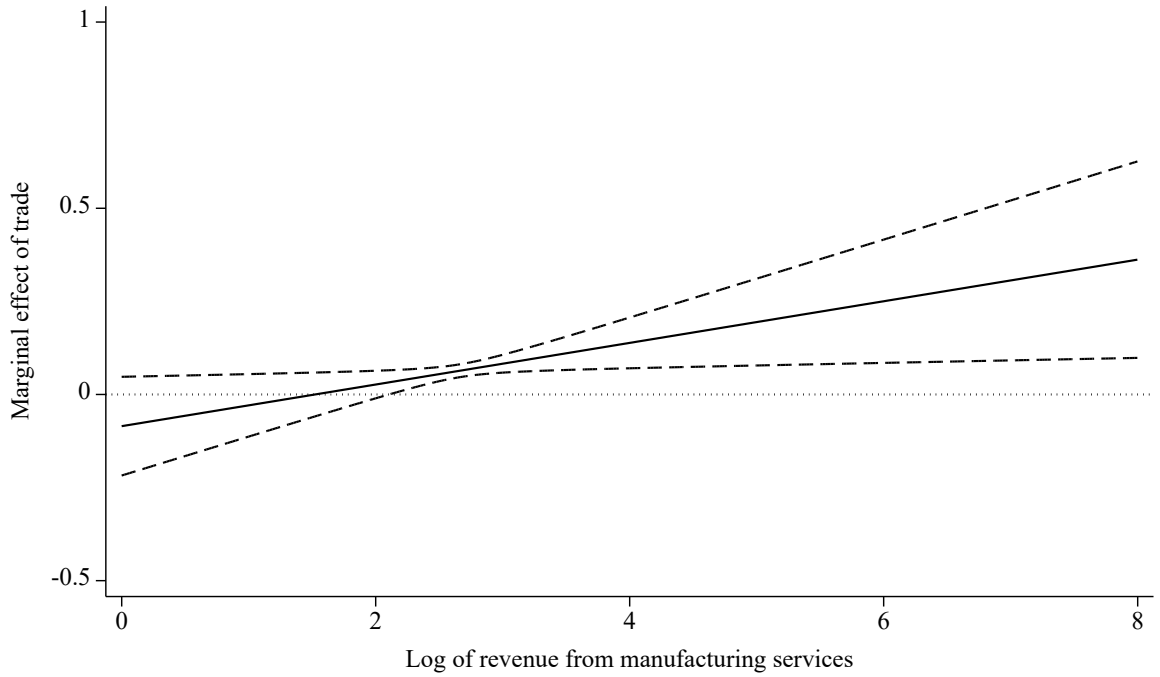
Figure 1. Measure of Offshoring and Foreign Value-Added Share of Gross Exports



Notes: Industries are ranked in order of highest to lowest for our narrowly-defined offshoring measure, and the bar chart indicates the foreign value-added share of gross exports of industries. Foreign value-added share of gross exports from the OECD TiVA database is only available at the two-digit industry level (ISIC), so we aggregate our measure of offshoring (originally at the three-digit level) for compatibility.

Figure 2. Marginal Effect of Trade by Outsourcing Revenues



Notes: The dashed lines indicate the 95% confidence intervals.

Table 1. Education Attainment of Indonesian Residents in 2005

Educational background	Male (%)	Female (%)	Total (%)
Less than primary	24	34	29
Primary	32	32	32
Junior high	16	13	14
High	24	17	21
University	5	3	4
Total	100	100	100

Notes: Age of residents is equal to or above 25.

Source: Minnesota Population Center, *Intercensal Population Survey* 2005.

Table 2. Summary Statistics

Variable	Mean	Std. Dev.
Share of female workers in total employment	0.411	0.294
Share of female workers in production occupation	0.407	0.323
Share of female workers in non-production occupation	0.351	0.271
Log of number of male workers in total employment	3.393	1.296
Log of number of female workers in total employment	2.922	1.479
Log of value added in 1,000 rupiahs (2000=100)	13.180	1.988
Log of capital to value-added ratio	-0.120	1.532
Share of workers in non-production occupation in total employment	0.151	0.162
Total factor productivity	6.068	1.625
Log of revenue from manufacturing services in 1,000 rupiahs (2000=100)	1.726	4.346
Dummy variable		
FDI: one if a plant is a foreign affiliate of MNEs; zero otherwise	0.065	0.247
exp: one if a plant exports products; zero otherwise	0.193	0.395
imp: one if a plant imports materials; zero otherwise	0.135	0.342
exim: one if a plant exports products and imports materials; zero otherwise	0.057	0.232

Source: BPS, *Annual Survey of Medium and Large Manufacturing Establishment*, various years.

Table 3. Effects on Female Employment in All Occupations: OLS

Variables	(1)	(2)	(3)	(4)
ln(value added)	0.00328***	-0.000924	0.00122	0.000894
	(0.00114)	(0.00118)	(0.00116)	(0.00116)
ln(capital/value added)	-0.0407***	-0.0404***	-0.0409***	-0.0407***
	(0.00114)	(0.00113)	(0.00113)	(0.00113)
ln(skill intensity)	-0.218***	-0.215***	-0.219***	-0.216***
	(0.00806)	(0.00804)	(0.00805)	(0.00805)
ln(TFP)	-0.0784***	-0.0745***	-0.0772***	-0.0765***
	(0.00182)	(0.00184)	(0.00182)	(0.00183)
FDI	0.0536***	0.0381***	0.0432***	0.0387***
	(0.00591)	(0.00587)	(0.00587)	(0.00583)
ln(outsourcing)	-0.00104***	-0.00165***	-0.00136***	-0.00130***
	(0.000243)	(0.000274)	(0.000273)	(0.000255)
exp		0.0476***		
		(0.00360)		
ln(outsourcing) x exp		0.00246***		
		(0.000472)		
imp			0.0346***	
			(0.00433)	
ln(outsourcing) x imp			0.00176***	
			(0.000507)	
exim				0.0528***
				(0.00594)
ln(outsourcing) x exim				0.00286***
				(0.000663)
Observations	148,756	148,756	148,756	148,756
R-squared	0.364	0.368	0.366	0.366

Notes: This table shows the OLS results. The dependent variable is the share of female employment in the total employment of a plant. All specifications include the industry-year and region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Table 4. Effects on Female Employment in All Occupations: TSLS

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ln(value added)	-0.00391	-0.00659	-0.00452	-0.00410	-0.000593	0.0501
	(0.00348)	(0.00410)	(0.00394)	(0.00369)	(0.00379)	(0.0338)
ln(capital/value added)	-0.0438***	-0.0423***	-0.0430***	-0.0423***	-0.0415***	-0.0413***
	(0.00188)	(0.00202)	(0.00198)	(0.00186)	(0.00202)	(0.00171)
ln(skill intensity)	-0.246***	-0.229***	-0.236***	-0.232***	-0.223***	-0.290***
	(0.0156)	(0.0170)	(0.0167)	(0.0154)	(0.0172)	(0.0267)
ln(TFP)	-0.0786***	-0.0743***	-0.0771***	-0.0757***	-0.0774***	-0.114***
	(0.00199)	(0.00208)	(0.00197)	(0.00199)	(0.00198)	(0.0274)
FDI	0.0439***	0.0135	0.0287***	0.0304***	-0.103*	0.168*
	(0.00788)	(0.0108)	(0.00923)	(0.00881)	(0.0575)	(0.0886)
ln(outsourcing)	0.0284**	0.00358	0.0139	0.0144	0.0102	
	(0.0135)	(0.0150)	(0.0150)	(0.0135)	(0.0152)	
exp		-0.0846***				
		(0.0301)				
ln(outsourcing) x exp		0.0665***				
		(0.0144)				
imp			-0.0488			
			(0.0326)			
ln(outsourcing) x imp			0.0412***			
			(0.0143)			
exim				-0.0851		
				(0.0676)		
ln(outsourcing) x exim				0.0559**		
				(0.0252)		
ln(outsourcing) x FDI					0.0523***	
					(0.0197)	
ln(exports)						-0.0343
						(0.0245)
Observations	148,756	148,756	148,756	148,756	148,756	59,055
Kleibergen-Paap *F*	20.48	10.24	9.976	10.96	10.79	8.327

Notes: This table reports the TSLS results, where the instrument is the share of world import demand for product *k* in world total import demand. The dependent variable is the share of female employment in the total employment of a plant. All specifications include the industry-year and region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Table 5. Effects on the Number of Workers by Gender

Variables	(1) Male	(2) Female	(3) Male	(4) Female	(5) Male	(6) Female	(7) Male	(8) Female	(9) Female/Male
ln(outsourcing)	-0.105**	0.0393	-0.0716*	-0.0705	-0.0911**	-0.0380	-0.0810**	-0.0218	0.0676
	(0.0425)	(0.0494)	(0.0411)	(0.0590)	(0.0411)	(0.0588)	(0.0377)	(0.0524)	(0.0794)
exp			0.198**	-0.265**					
			(0.0831)	(0.105)					
ln(outsourcing) x exp			-0.0834**	0.288***					
			(0.0400)	(0.0488)					
imp					0.0622	-0.250**			
					(0.0955)	(0.115)			
ln(outsourcing) x imp					-0.0324	0.208***			
					(0.0425)	(0.0495)			
exim							0.283	-0.218	-0.495
							(0.205)	(0.205)	(0.389)
ln(outsourcing) x exim							-0.0846	0.242***	0.326**
							(0.0768)	(0.0749)	(0.144)
Observations	147,725	141,614	147,725	141,614	147,725	141,614	147,725	141,614	140,583
Kleibergen-Paap *F*	20.12	18.87	10.02	9.409	9.909	9.072	10.76	10.05	9.823

Notes: This table reports the TSLS results, where the instrument is the share of world import demand for product *k* in world total import demand. Plant-level control variables are omitted. The dependent variable is the number of male workers (Columns (1), (3), (5), and (7)), female workers (Columns (2), (4), (6), and (8)), or the ratio of female to male employment (the last column) in all occupations, all of which are logarithms. All specifications include the industry-year fixed effects and the region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Table 6. Effects on Female Employment in Production and Non-Production Occupations

Variables	(1) Production	(2) Non-production	(3) Production	(4) Non-production	(5) Production	(6) Non-production	(7) Production	(8) Non-production	(9) Ratio of Non-prod.
ln(outsourcing)	0.0295**	0.0507***	0.00355	0.0509**	0.0137	0.0615***	0.0159	0.0480***	0.0168
	(0.0145)	(0.0178)	(0.0162)	(0.0200)	(0.0162)	(0.0219)	(0.0146)	(0.0178)	(0.0118)
exp			-0.0837***	0.0205					
			(0.0322)	(0.0282)					
ln(outsourcing) x exp			0.0699***	0.000634					
			(0.0153)	(0.0126)					
imp					-0.0544	0.0516			
					(0.0351)	(0.0340)			
ln(outsourcing) x imp					0.0440***	-0.0142			
					(0.0154)	(0.0139)			
exim							-0.0752	-1.30e-05	0.00819
							(0.0700)	(0.0548)	(0.0268)
ln(outsourcing) x exim							0.0550**	0.0101	-0.0171*
							(0.0260)	(0.0199)	(0.00878)
Observations	148,734	127,095	148,734	127,095	148,734	127,095	148,734	127,095	141,614
Kleibergen-Paap *F*	20.53	13.24	10.26	6.169	10.01	6.018	10.99	6.849	10.05

Notes: This table reports the TSLS results, where the instrument is the share of world import demand for product *k* in world total import demand. Plant-level control variables are omitted. The dependent variable is the share of female employment in the production occupations of a plant in Columns (1), (3), (5), and (7), the share in the non-production occupations in Columns (2), (4), (6), and (8), or the ratio of non-production female workers to female employment in the last column. All specifications include the industry-year fixed effects and the region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Table 7. Heterogeneous Effects on Female Employment in Production Occupations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	Industries with the low educated				Low-technology industries				Light industries			
ln(outsourcing)	0.0167	0.00243	0.0160	0.0215	0.0168	0.00167	0.0141	0.0199	-0.0197	-0.0339*	-0.0221	-0.0114
	(0.0150)	(0.0171)	(0.0167)	(0.0169)	(0.0157)	(0.0177)	(0.0174)	(0.0174)	(0.0182)	(0.0203)	(0.0204)	(0.0192)
exp		-0.124***				-0.127***				-0.156***		
		(0.0341)				(0.0345)				(0.0363)		
ln(outsourcing) x exp		0.0955***				0.0939***				0.112***		
		(0.0168)				(0.0167)				(0.0174)		
imp			-0.0815**				-0.0711*				-0.0988***	
			(0.0402)				(0.0378)				(0.0350)	
ln(outsourcing) x imp			0.0632***				0.0526***				0.0655***	
			(0.0187)				(0.0167)				(0.0143)	
exim				-0.212**				-0.207*				-0.280**
				(0.106)				(0.107)				(0.111)
ln(outsourcing) x exim				0.109***				0.105***				0.127***
				(0.0396)				(0.0395)				(0.0392)
Observations	128,392	128,392	128,392	128,392	136,917	136,917	136,917	136,917	107,053	107,053	107,053	107,053
Kleibergen-Paap *F*	24.38	12.67	11.52	11.88	21.18	10.87	9.968	10.31	17.34	9.034	7.569	8.171

Notes: This table reports the TSLS results, where the instrument is the share of world import demand for product *k* in world total import demand. Plant-level control variables are omitted. The dependent variable is the share of female employment in the production occupation of a plant. Columns (1)–(4) present the results for industries that intensively employ low-educated workers. Columns (5)–(8) present the results for low-technology industries, while Columns (9)–(12) present those for light industries. All specifications include the industry-year fixed effects and the region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Appendix

Table A1. First-stage Results of Table 4

	(1)	(2)		(3)		(4)	
Excluded instruments	ln(outs.)	ln(outs.)	ln(outs.) x exp	ln(outs.)	ln(outs.) x imp	ln(outs.)	ln(outs.) x exim
IV	84.01***	79.24***	-33.11***	82.11***	-23.81***	89.51***	-12.48***
	(18.56)	(21.10)	(4.953)	(21.00)	(5.035)	(20.25)	(3.539)
IV x exp		12.52	180.3***				
		(33.55)	(30.73)				
IV x imp				-0.407	170.1***		
				(37.01)	(32.65)		
IV x exim						-21.69	129.5***
						(40.81)	(38.42)
Observations	148,756	148,756	148,756	148,756	148,756	148,756	148,756

Notes: This table reports the first-stage results of the TSLS estimations in Columns (1)–(4) of Table 4. The instrument variables are the share of world import demand for product *k* in world total import demand and its interaction with the trade status of a plant. All specifications include the industry-year and region-year fixed effects. Robust standard errors clustered at the plant level are shown in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.